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Sampling and Operations Plan for Asbestos Dump
New Vernon Road, Meyersville, New Jersey
As part of NPL Removal Assessment, 1990

Prepared for:
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1. PROJECT NAME: Asbestos Dump
New Vernon Rd. Meyersville
Morris County, NJ

2. PROJECT REQUESTED BY: Mike Neill
Removal Action Branch

3. DATE REQUESTED: August 28, 1990

4. DATE OF PROJECT INITIATION: August 2, 1990

5. PROJECT ORGANIZATION AND RESPONSIBILITY:

The following is a list of key project personnel and their corresponding responsibilities:

Mike Neill, USEPA	Project Director
Thomas O'Neill, TAT II	Overall Project Coordination Sampling Operations QC
Anibal Diaz, TAT II	Laboratory Coordination & QC

6. PROJECT DESCRIPTION:

A. Site Description

The Asbestos Dump site consists of four areas located in Morris County New Jersey which together comprise a National Priority List (NPL) site. One of these areas; the New Vernon Road site is the focus of this sampling operation. A brief history of this area follows.

The New Vernon Road site consists of approximately 30 acres of land off New Vernon Road, in Meyersville, New Jersey. The New Vernon Road site was operated as a corn and dairy cattle farm from 1945-1980. During the late 1960's, asbestos refuse consisting of loose asbestos fibers, broken asbestos tiles and sidings was landfilled in two areas of the site. A small depression in the westernmost section of the property was filled first. Then, a larger depression in the middle of the property was filled. Both areas were later graded and seeded. The New Vernon Road site contains asbestos wastes in a small landfill area in front of the private residence, in the main landfill area in the center of the property, along the dirt path that traverses north-south along the middle of the property, and in the area of the shed located next to the private residence. The thickness of the waste is not known.

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7. AIR SAMPLING PROCEDURES

A. Laboratory's

All samples will be submitted to a private laboratory, with a 24 hour turnaround required. All laboratory QA/QC requirements will be followed, as well as PCM analytical methodology, i.e. field blank, lot blank requirements.

B. Objective and Scope

The objective of this project is to provide data pertaining to the quantity of airborne asbestos fibers surrounding the New Vernon Rd site. Samples will be taken at random locations at the site. The air samples will be taken using a continuous flow Gilian pump with a cellulose ester filter cassette. Samples will be taken at approximate heights of 4 and 6 feet above ground level, to approximate the breathing range of adults and children. The total number of samples taken at the site will be thirteen (13). The samples will consist of:

1. Airborne asbestos at (10) locations to be analyzed by phase contrast microscopy (PCM).
2. One (1) media sample.
3. Two (2) field blanks.

C. Data Usage

The data will provide information as to the extent and type of contamination in the immediate vicinity of the house, and hence if there is a potential threat to the health of the residents.

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D. Parameter Table

1. Air Samples:

Parameter	Sample Matrix	Sample No.	Analy. Mth. Ref.	Sample Prep.	Holding Time	Limit of Detection	Volume	Preserv.
Asbestos	Solid	*	PCM	N/A	N/A	N/A	1000-1200l	N/A

* The actual number will be based upon availability.

E. Sampling Procedures:

Air sampling will be conducted by drawing air through a filter at a rate of 2.5L/min. A sample volume 1000 - 1200 liters will be required. A continuous flow Gilian air pump with a cellulose ester filter cassette will be used. The filter cassette will have a 0.8-1.2 um pore size and a diameter of 25mm. Sampling procedures will follow NIOSH method 7400.

F. Sample Containers:

Filter cassettes will be placed upright in a rigid container so that cassette cap is on the top and cassette base is on the bottom. Cassettes will be packed to prevent jostling or damage. Filter cassettes will be hand delivered , if possible directly to the laboratory.

G. Sample Label:

Each sample will be accurately and completely identified. All labels will be moisture resistant and able to withstand field conditions. Sample containers will be labeled prior to sample collection. The information on each label will include the following, but is not limited to:

i. Date of collection
ii. Site name
iii. Sample identity/location
iv. Analysis requested

8. Soil Sampling Procedures

A. Laboratory's

All samples will be submitted to a private laboratory with a 48 hr turnaround required. Laboratory QA/QC as well as PLM methodology requirements will be used.

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B. Objective and Scope

The objective of this project is to provide data pertaining to the quantity and types of asbestos in the matrices surrounding the site. Samples of surface soil from the driveway on the north side of the property will be collected, along with shingle fragments from various locations at the site. The exact locations will be determined at the time of the sampling. The total number of samples taken from the site will be nine (9). The samples will consist of:

1. Surface soil samples at 7 locations to be analyzed by PLM methodology.

2. One (1) tile sample from the side of shed #1 to be analyzed by PLM methodology.

3. One (1) soil sample from a location off site (Edison).

C. Data Usage

The data will provide information as to the extent and type of contamination in the immediate vicinity of the site, and hence if there is any potential threat to the residents.

D. Parameter Table

1. Bulk Samples:

Parameter	Sample Matrix	Sample No.	Analy. Mth. Ref.	Sample Prep.	Holding Time	Limit of Detection	Volume	Preserv.
Asbestos Shingle	Solid	*	PLM	N/A	N/A	N/A	1000-1200L	N/A
Soil Samples	Solid	*	PLM	N/A	N/A	N/A	1000-1200L	N/A
Off-Site Soil Field Blank	Solid	*	PLM	N/A	N/A	N/A	1000-1200L	N/A

* The actual number will be based upon availability.

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E. Sampling Procedures

All soil samples will be collected between 0-6 inch depth using a trowel. The sample will then be transferred to a 1 Qt "zip-loc" plastic bag. Bulk samples of shingles will be placed directly in the bags. All samples will then be double bagged.

F. Sample Containers

All sample containers will be 1qt "zip-loc" plastic bags, or I-Chem laboratory pre-cleaned glassware, as specified by the EPA Sample Management Office Contract Lab Program.

G. Sample Label:

Each sample will be accurately and completely identified. All labels will be moisture resistant and able to withstand field conditions. Sample containers will be labeled prior to sample collection. The information on each label will include the following, but is not limited to:

i. Date of collection
ii. Site name
iii. Sample identity/location
iv. Analysis requested

9. Sample Custody Procedures:

EPA Chain-of-Custody will be filled out and maintained throughout the entire site activities as per TAT Standard Operating Procedures (SOP) on sample handling, Sample Container Contract specifications, and EPA Laboratories SOP. The Chain-of-Custody form to be used lists the following information:

i. Project name;
ii. Sample number;
iii. Number of sample containers;
iv. Description of samples including specific location of sample collection;
v. Identity of person collecting the sample;
vi. Date and time of sample collection;
vii. Date and time of custody transfer to laboratory (if the sample was collected by a person other than laboratory personnel);
viii. Identity of person accepting custody (if the sample was collected by a person other than the laboratory personnel);
ix. Identity of laboratory performing the analysis.

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10. Documentation, Data Reductions, and Reporting:

Field data will be entered into a bound notebook. Field notebooks, Chain-of-Custody forms, and laboratory analysis reports will be filed and stored per the TAT Document Control System.

All results are to be completed and a written report submitted by the lab to the TAT QC officer within seven (7) days of the Validated Time of Sample Receipt (VTSR).

11. Data Validation:

All steps of data generation and handling will be evaluated by the Project Officer and the Quality Assurance Officer for compliance with the specified requirements.

12. System Audit:

The Quality Control Officer will observe the sampling operations and subsequent analytical data to assure that the QA/QC project plan has been followed

13. Corrective Action:

All precautions will be taken in the field and laboratory to ensure that any problems that may develop will be dealt with as quickly as possible. This will be done to ensure the continuity of the sampling program. Any deviations from this sampling plan will be noted in the final report.

14. Reports:

Laboratory results and all requested QA/QC information will be submitted to EPA upon completion of sample analyses. Sampling reports will be issued after receipt of laboratory results.

15. Project Fiscal Information:

Sampling equipment and manpower shall be provided by the Technical Assistance Team (TAT) in coordination with the USEPA. All man-hours expended by TAT will be charged to TDD # 02-90-0815.

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Appendix A

POLARIZED LIGHT MICROSCOPY (PLM) METHOD

FORMULA: various

M.W.: various

ASBESTOS (bulk)

METHOD: 9002

ISSUED: 5/15/89

EPA Standard (Bulk): 1%

PROPERTIES: solid, fibrous, crystalline, anisotropic

SYNONYMS: actinolite [CAS #13768-00-8], or ferroactinolite; cummingtonite-grunerite (amosite) [CAS #12172-73-5]; anthophyllite [CAS #17068-78-9]; chrysotile [CAS #12001-29-5] or serpentine; crocidolite [CAS #12001-28-4] or riebeckite; tremolite [CAS #14567-73-8]; amphibole asbestos.

SAMPLING

BULK SAMPLE: 1 to 10 grams

SHIPMENT: seal securely to prevent escape of asbestos

SAMPLE STABILITY: stable

BLANKS: none required

ACCURACY

RANGE STUDIED: <1% to 100% asbestos

BIAS: not determined

PRECISION: not determined

MEASUREMENT

TECHNIQUE: MICROSCOPY, STEREO AND POLARIZED LIGHT, WITH DISPERSION STAINING

ANALYTE: actinolite asbestos, amosite, anthophyllite asbestos, chrysotile, crocidolite, tremolite asbestos

EQUIPMENT: microscope, polarized light: 100-400X dispersion staining objective, stereo microscope: 10-45X

RANGE: 1% to 100% asbestos

ESTIMATED LOD: <1% asbestos [1]

PRECISION: not determined

APPLICABILITY: This method is useful for the qualitative identification of asbestos and the semi-quantitative determination of asbestos content of bulk samples, expressed as a percent of projected area. The method measures percent asbestos as perceived by the analyst in comparison to standard area projections, photos, and drawings, or trained experience. The method is not applicable to samples containing large amounts of fine fibers below the resolution of the light microscope.

INTERFERENCES: Other fibers with optical properties similar to the asbestos minerals may give positive interferences. Optical properties of asbestos may be obscured by coating on the fibers. Fibers finer than the resolving power of the microscope (ca. 0.3 µm) will not be detected. Heat and acid treatment may alter the index of refraction of asbestos and change its color.

OTHER METHODS: This method (originally designated as method 7403) is designed for use with NIOSH Methods 7400 (phase contrast microscopy) and 7402 (electron microscopy/EDS). The method is similar to the EPA bulk asbestos method [1].

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5. In a hood, open sample container and with tweezers remove small, representative portions of the sample.
   a. If there are obvious separable layers, sample and analyze each layer separately.
   b. If the sample appears to be slightly inhomogeneous, mix it in the sample container with tweezers or a spatula before taking the portion for analysis. Alternatively, take small representative portions of each type of material and place on a glass slide.
   c. On hard tiles that may have thin, inseparable layers, use a scalpel to cut through all the layers for a representative sample. Then cut it into smaller pieces after placing RI liquid on it before trying to reduce the thickness. Alternatively, use a low-speed hand drill equipped with a burr bit to remove material from hard tiles. Avoid excessive heating of the sample which may alter the optical properties of the material.
   NOTE: This type of sample often requires ashing or other specialized preparation.
   d. If the sample has large, hard particles, grind it in a mortar. Do not grind so fine that fiber characteristics are destroyed.
   e. If necessary, treat a portion of the sample in a hood with an appropriate s[illegible]nt to remove binders, tars, and other interfering materials which may be present [illegible] the sample. Make corrections for the non-asbestos material removed by this process.
   NOTE: Other methods of sample preparation such as acid and sodium metaphosphate treatment and ashing are not normally necessary. However, if needed, use as described in Reference [1].
6. After placing a few drops of RI liquid on the slide, put a small portion of sample in the liquid. Tease apart with a needle or smash small clumps with the flat end of a spatula or probe, producing a uniform thickness of particles so that better estimates of projected area percentages can be made. Mix the fibers and particles on the slide so that they are as homogeneous as possible.
   NOTE: An even dispersion of sample should cover the entire area under the cover slip. Some practice will be necessary to judge the right amount of material to place on the slide. Too little sample may not give sufficient information and too much sample cannot be easily analyzed.

CALIBRATION AND QUALITY CONTROL:

7. Check for contamination of microscope slides, cover slips and refractive index liquids once per day of operation. Record results in a separate logbook.
8. Verify the refractive indices of the refractive index liquids used once per week of operation. Record these checks in a separate logbook.
9. Follow the manufacturer's instructions for illumination, condenser alignment and other microscope adjustments. Perform these adjustments prior to each sample set.
10. Determine precent of each identified asbestos species by comparision to standard projections (Figure 1) [1]. If no fibers are detected in a homogeneous sample, examine at least two additional preparations before concluding that no asbestos is present.
11. If it appears that the preparation technique might not be able to produce a homogeneous or representative sample on the slide, prepare a duplicate slide and average the results. Occasionally, when the duplicate results vary greatly, it will be necessary to prepare additional replicate slides and average all the replicate results. Prepare duplicate slides of at least 10% of the samples analyzed. Average the results for reporting.
12. Analyze about 5% blind samples of known asbestos content.
13. Laboratories performing this analytical method should participate in the National Voluntary Labortory Accreditation Program [5] or a similar interlaboratory quality control program. Each analyst should have completed formal training in polarized light microscopy and its application to crystalline materials. In lieu of formal training, laboratory training in asbestos bulk analysis under the direction of a trained asbestos bulk analyst may be substituted. Due to the subjective nature of the method, frequent practice is essential in order to remain proficient in estimating projected area percentages.

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h. Identification of amosite. Prepare a slide in 1.680 RI liquid. Observe the fiber morphology for amosite characteristics: straight fibers and fiber bundles with broom-like or splayed ends. If the morphology matches amosite, examine the fibers using the dispersion staining objective. Blue and pale blue colors indicate the cummingtonite form of amosite, and gold and blue colors indicate the grunerite form of amosite. If amosite is confirmed by this test, go to step 15 for quantitative estimation, otherwise continue.

i. Identification of anthophyllite-tremolite-actinolite. Prepare a slide in 1.605 HD RI liquid. Examine morphology for comparision to anthophyllite-tremolite-actinolite asbestos. The refractive indices for these forms of asbestos vary naturally within the species. Anthophyllite can be distinguished from actinolite and tremolite by its nearly parallel extinction. Actinolite has a light to dark green color under plane-polarized light and exhibits some pleochroism. For all three, fibers will be straight, single fibers possibly with some larger composite fibers. Cleavage fragments may also be present. Examine using the central stop dispersion staining objective. Anthophyllite will exhibit central stop colors of blue and gold/gold-magenta; tremolite will exhibit pale blue and yellow; and actinolite will exhibit magenta and golden-yellow colors.

NOTE: In this refractive index range, wollastonite is a common interfering mineral with similiar morphology including the presence of cleavage fragments. It has both positive and negative sign of elongation, parallel extinction, and central stop dispersion staining colors of pale yellow and pale yellow to magenta. If further confirmation of wollastonite versus anthophyllite is needed, go to step "j". If any of the above forms of asbestos was confirmed above, go to step 15 for quantitative estimation. If none of the tests above confirmed asbestos fibers, examine the additional preparations and if the same result occurs, report the absence of asbestos in this sample.

j. Wash a small portion of the sample in a drop of concentrated hydrochloric acid on a slide. Place the slide, with cover slip in place, on a warm hot plate until dry. By capillary action, place 1.620 RI liquid under the cover slip and examine the slide. Wollastonite fibers will have a "cross-hatched" appearance across the length of the fibers and will not show central stop dispersion colors. Anthophyllite and tremolite will still show their original dispersion colors.

NOTE: There are alternative analysis procedures to the step-wise approach outlined above which will yield equivalent results. Some of these alternatives are:

i. Perform the initial scan for the presence of asbestos using crossed polars as well as the first-order red compensator. This allows for simultaneous viewing of birefringent and amorphous materials as well as determining their sign of elongation. Some fibers which are covered with mortar may best be observed using this configuration.

ii. Some analysts prefer to mount their first preparation in a RI liquid different than any asbestos materials and conduct their initial examination under plane-polarized light.

iii. If alternative RI liquids are used from those specified, dispersion staining colors observed will also change. Refer to an appropriate reference for the specific colors associated with asbestos in the RI liquids actually used.

QUANTITATIVE ASSESSMENT:

15. Estimate the content of the asbestos type present in the sample using the 1.550 RI preparation. Express the estimate as an area percent of all material present, taking into account the loading and distribution of all sample material on the slide. Use Figure 1 as an aid in arriving at your estimate. If additional unidentified fibers are present in the sample, continue with the qualitative measurement (step 14).

NOTE: Point-counting techniques to determine percentages of the asbestos minerals are not generally recommended. The point-counting method only produces accurate quantitative

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Figure 1. Percent estimate comparator.

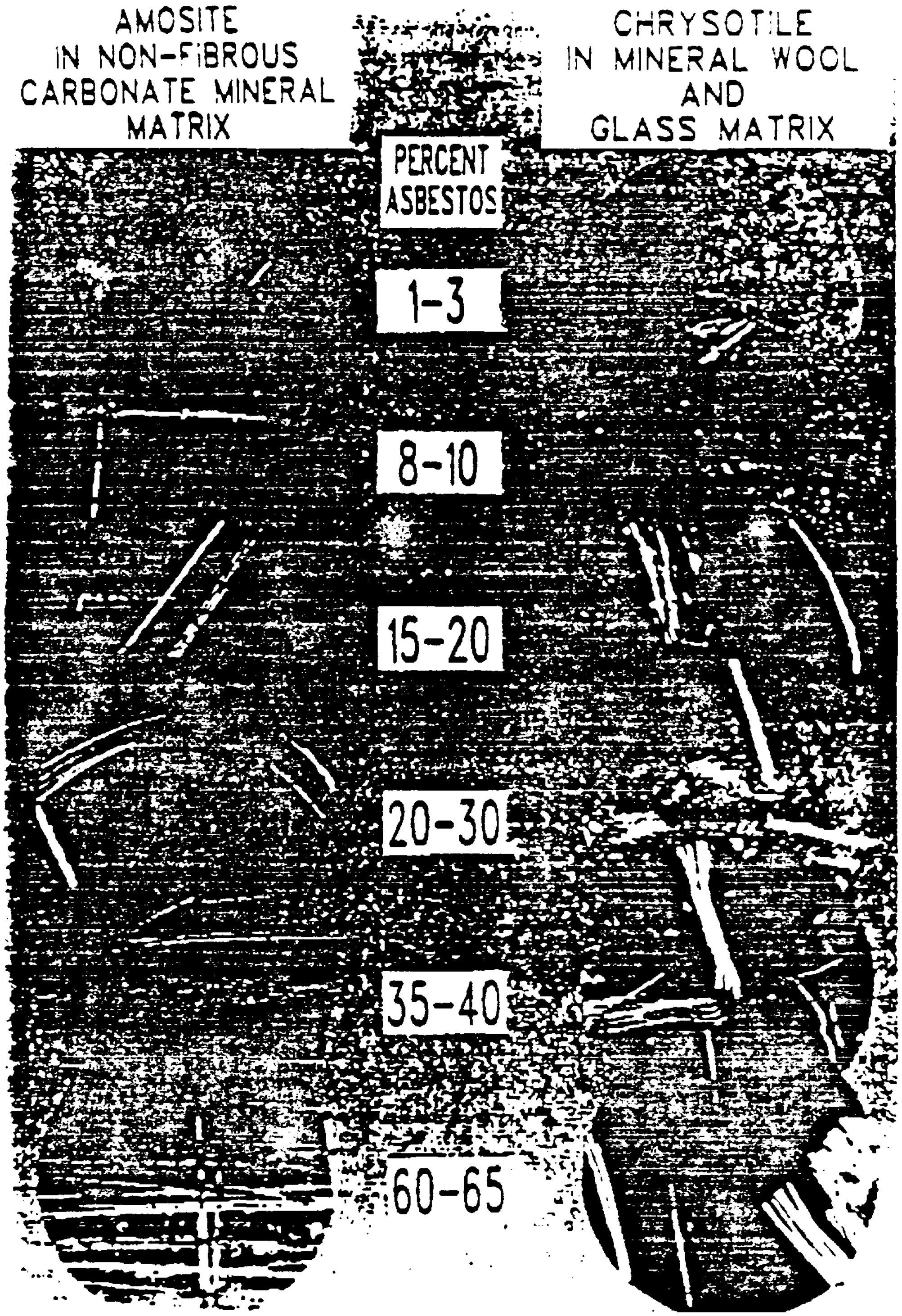

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Table 1. Optical Properties of Asbestos Fibers (Continued)

			Central Stop Dispersion Staining Colors		
Mineral	Extinction	Sign of Elongation	RI Liquid	⊥ to Vibration	‖ to Vibration
Chrysotile	Parallel to fiber length	+ (length slow)	1.550 HD	Blue	Blue-magenta
Cummingtonite-Grunerite (Amosite)	Parallel to fiber length	+ (length slow)	1.670	Red magenta to blue	Yellow
			Fibers subjected to high temperatures will not dispersion-stain.		
Cummingtonite			1.680	pale blue	blue
Grunerite			1.680	blue	gold
Crocidolite (Riebeckite)	Parallel to fiber length	- (length fast)	1.700	Red magenta	Blue-magenta
			1.680	yellow	pale yellow
Anthophyllite	Parallel to fiber length	+ (length slow)	1.605 HD	Blue	Gold to gold-magenta
			1.620 HD	Blue-green	Golden-yellow
Tremolite-Actinolite	Oblique - 10 to 20° for fragments. Some composite fibers show ‖ extinction.	+ (length slow)	1.605 HD	Pale blue (tremolite)	Yellow (tremolite)
				Yellow (actinolite)	Pale yellow (actinolite)

HD = high-dispersion RI liquid series.

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Appendix B

NIOSH METHOD 7402 (TEM)

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FORMULA: various

M.W.: various

ASBESTOS FIBERS
METHOD: 7402
ISSUED: 8/15/87

OSHA: 0.2 asbestos fibers (>5 µm long/mL)
NIOSH: 0.1 asbestos f/mL [1]
ACGIH: 0.2 crocidolite; 0.5 amosite; 2 chrysotile and other asbestos, f/mL

PROPERTIES: solid, fibrous

SYNONYMS: actinolite asbestos [CAS #13768-00-8], grunerite asbestos (amosite) [CAS #12172-73-5], anthophyllite asbestos [CAS #17068-78-9], chrysotile asbestos [CAS #12001-29-5], crocidolite asbestos [CAS #12001-28-4], tremolite asbestos [CAS #14567-73-8].

SAMPLING	MEASUREMENT
SAMPLER: FILTER (0.8-to 1.2-µm cellulose ester membrane, 25-mm diameter; conductive cassette)	TECHNIQUE: MICROSCOPY, TRANSMISSION ELECTRON (TEM)
FLOW RATE*: 0.5 to 16 L/min (step 4)	ANALYTE: asbestos fibers
VOL-MIN*: 400 L @ 0.1 fiber/mL (step 4) -MAX*: (step 4) *Adjust for 100 to 1300 fibers/mm² (step 4)	SAMPLE PREPARATION: modified Jaffe wick
SHIPMENT: routine (securely packed to reduce shock)	EQUIPMENT: transmission electron microscope; energy dispersive X-ray system (EDS) analyzer
SAMPLE STABILITY: stable	CALIBRATION: qualitative electron diffraction; calibration of TEM magnification and EDS system
FIELD BLANKS: 10% (≥2) of samples	RANGE: 100 to 1300 fibers/mm² filter area [2]
ACCURACY	ESTIMATED LOD: 1 confirmed asbestos fiber above 95% of expected mean blank value
RANGE STUDIED: 80 to 100 fibers counted	PRECISION: 0.28 when 65% of fibers are asbestos; 0.20 when adjusted fiber count is applied to PCM count [3].
BIAS: not determined	
OVERALL PRECISION (s_r): see EVALUATION OF METHOD	

APPLICABILITY: The working range is 0.04 to 0.5 fiber/mL for a 1-m³ air sample. The method measures asbestos fibers of the smallest diameter (<0.05 µm) but allows comparison of fiber counts to be made with phase contrast light microscopic (PCM) data when fiber diameters are rigidly defined.

INTERFERENCES: Non-asbestiform amphiboles may interfere in the TEM analysis if the individual particles have aspect ratios greater than 3:1. These interferences can only be eliminated by quantitative zone axis electron diffraction analysis. High concentrations of background dust interfere with fiber identification.

OTHER METHODS: NIOSH Method 7400 (dated 8/15/87) (phase-contrast microscopy) designed for use with this method.

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REAGENTS:

1. Acetone. See SPECIAL PRECAUTIONS.

EQUIPMENT:

1. Sampler: field monitor, 25-mm, three-piece cassette with ca. 50-mm electrically-conductive extension cowl, cellulose ester membrane filter, 0.8- to 1.2-µm pore size, and backup pad.
   NOTE 1: Analyze representative filters for fiber background before use. Discard the filter lot if mean count is >5 fibers/100 fields. These are defined as laboratory blanks.
   NOTE 2: Use an electrically-conductive extension cowl to reduce electrostatic effects on fiber sampling and during sample shipment. Ground the cowl when possible during sampling.
2. Personal sampling pump, ≥0.5 L/min (see step 4 for flow rate), with flexible connecting tubing.
3. Microscope, transmission electron, operated at 100 kV, with electron diffraction and energy-dispersive X-ray capabilities, and having a fluorescent screen with inscribed or overlaid calibrated scale (Step 15).
   NOTE: The scale is most efficient if it consists of a series of lines inscribed on the screen or partial circles every 2 cm distant from the center.
4. Diffraction grating replica with known number of lines/mm.
5. Slides, glass, pre-cleaned, 25- x 75-mm.
6. Knife, #10 surgical steel, curved-blade.
7. Tweezers.
8. Grids, 200-mesh TEM copper, carbon-coated.
9. Petri dishes, 15-mm depth. The top and bottom of the petri dish must fit snugly together. To assure a tight fit, grind the top and bottom pieces together with an abrasive such as carborundum to produce a ground-glass contact surface.
10. Foam, clean polyurethane, spongy, 12-mm thick.
11. Low-temperature oxygen plasma asher.
12. Filters, Whatman No. 1 qualitative paper or equivalent, or lens paper.
13. Vacuum evaporator.
14. Cork borer, No. 5 (8-mm).
15. Pen, waterproof, marking.
16. Reinforcement, page, gummed.
17. Asbestos standard bulk materials for reference.
18. Carbon rods, sharpened to 1 mm x 8 mm.
19. Microscope, light, phase contrast (PCM), with Walton-Beckett graticule (see method 7400).
20. Grounding wire, 22-gauge, multi-strand.

SPECIAL PRECAUTIONS: Acetone is extremely flammable (flash point = 0 °F). Take precautions not to ignite it. Heating of >1 mL acetone must be done in a fume hood using a flameless, spark-free heat source.

SAMPLING:

1. Calibrate each personal sampling pump with a representative sampler in line [4].
2. For personal sampling, fasten sampler to worker's lapel near worker's mouth. Remove the top cover from end of the cowl extension (open face) and orient sampler face down. Wrap joint between extender and monitor body with shrink tape to prevent air leaks. Where possible, especially at low %RH, attach sampler to electrical ground to reduce electrostatic effects during sampling.

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3. Submit at least two field blanks (or 10% of the total samples, whichever is greater) for each set of samples. Remove top covers from the field blank cassettes and store top covers and cassettes in a clean area (e.g., closed bag or box) during sampling. Replace top covers when sampling is completed.
4. Sample at 0.5 L/min or greater [5]. Adjust sampling rate, Q (L/min), and time, t (min), to produce fiber density, E, of 100 to 1300 fibers/mm² [$3.85 \cdot 10^4$ to $5 \cdot 10^5$ fibers per 25-mm filter with effective collection area (A_c= 385 mm²)] for optimum accuracy. Do not exceed ca. 0.5 mg total dust loading on the filter. These variables are related to the action level (one-half the current standard), L (fibers/mL), of the fibrous aerosol being sampled by:

$$t = \frac{A_c \cdot E}{Q \cdot L \cdot 10^3}\text{, min.}$$

NOTE: The purpose of adjusting sampling times is to obtain optimum fiber loading on the filter. A sampling rate of 1 to 4 L/min for 8 hrs (700 to 2800 L) is appropriate in non-dusty atmospheres containing ca. 0.1 fiber/mL. Dusty atmospheres require smaller sample volumes (≤400 L) to obtain countable samples. In such cases take short, consecutive samples and average the results over the total collection time. For documenting episodic exposures, use high rates (7 to 16 L/min) over shorter sampling times. In relatively clean atmospheres, where targeted fiber concentrations are much less than 0.1 fiber/mL, use larger sample volumes (3000 to 10000 L) to achieve quantifiable loadings. Take care, however, not to overload the filter with background dust [5].

5. At the end of sampling, replace top cover and small end caps.
6. Ship samples upright with conductive cowl attached in a rigid container with packing material to prevent jostling or damage.

NOTE: Do not use untreated polystyrene foam in the shipping container because electrostatic forces may cause fiber loss from sample filter.

SAMPLE PREPARATION:

7. Remove a circular section from any quadrant of each sample and blank filter using a cork borer [6].
8. Affix the circular filter section to a clean glass slide with a gummed page reinforcement. Label the slide with a waterproof marking pen.

NOTE: Up to eight filter sections may be attached to the same slide.

9. Place the slide in a petri dish which contains several paper filters soaked with 2 to 3 mL acetone. Cover the dish. Wait 2 to 4 min for the sample filter(s) to fuse and clear.

NOTE: The "hot block" clearing technique may be used instead of steps 8 and 9 [7,8].

10. Place the slide containing the collapsed filters into a low-temperature plasma asher. Etch at 100 °C for ca. 2 min at an O_2 pressure of 130 Pa (1 mm Hg) [9].

NOTE: Plasma ashers may vary. Determine optimum etching time (ca. 1/2 the time needed to completely ash a filter) on blank filters before etching samples.

11. Transfer the slide to a rotating stage inside the bell jar of a vacuum evaporator. Evaporate a 1- by 5-mm section of a graphite rod onto the cleared filter(s). Remove the slide to a clean, dry, covered petri dish [6].
12. Prepare a second petri dish as a Jaffe wick washer with the wicking substrate prepared from filter or lens paper placed on top of a 12-mm thick disk of clean, spongy polyurethane foam [10]. Cut a V-notch on the edge of the foam and filter paper. Use the V-notch as a reservoir for adding solvent.

NOTE: The wicking substrate should be thin enough to fit into the petri dish without touching the lid.

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13. Place the carbon-coated TEM grids face up on the filter or lens paper. Label the grids by marking with a pencil on the filter paper or by putting registration marks on the petri dish halves and marking with a waterproof marker on the dish lid. In a fume hood, fill the dish with acetone until the wicking substrate is saturated.
    NOTE: The level of acetone should be just high enough to saturate the filter paper without creating puddles.
14. Remove about a quarter section of the carbon-coated filter from the glass slide using a surgical knife and tweezers. Carefully place the excised filter, carbon side down, on the appropriately-labeled grid in the acetone-saturated petri dish. When all filter sections have been transferred, slowly add more solvent to the wedge-shaped trough to bring the acetone level up to the highest possible level without disturbing the sample preparations. Cover the petri dish. Elevate one side of the petri dish by placing a slide under it (allowing drops of condensed acetone to form near the edge rather than in the center where they would drip onto the grid preparation).

CALIBRATION AND QUALITY CONTROL:

15. Determine the TEM magnification on the fluorescent screen:
    a. Define a field of view on the fluorescent screen either by markings or physical boundaries.
       NOTE: The field of view must be measurable or previously inscribed with a scale or concentric circles (all scales should be metric) [10].
    b. Insert a diffraction grating replica into the specimen holder and place into the microscope. Orient the replica so that the grating lines fall perpendicular to the scale on the TEM fluorescent screen. Ensure that goniometer stage tilt is zero.
    c. Adjust microscope magnification to 10,000X. Measure the distance (mm) between the same relative positions (e.g., between left edges) of two widely-separated lines on the grating replica. Count the number of spaces between the lines.
       NOTE: On most microscopes the magnification is substantially constant only within the central 8 to 10 cm diameter region of the fluorescent screen.
    d. Calculate the true magnification (M) on the fluorescent screen:

$$M = \frac{X \cdot G}{Y}$$

where: X = total distance (mm) between the two grating lines;
G = calibration constant of the grating replica (lines/mm);
Y = number of grating replica spaces counted

    e. After calibration, note the apparent sizes of 0.25 and 3.0 µm on the fluorescent screen. (These dimensions are essentially the diameter boundary limits for counting asbestos fibers by phase contrast microscopy.)
16. Measure 20 grid openings at random on a 200-mesh copper grid by placing a grid on a glass slide and examining it under the PCM. Use the Walton-Beckett graticule to measure the grid opening diameters. Calculate an average graticule field diameter from the data and use this number to calculate the graticule field area for an average grid opening.
    NOTE: A grid opening is considered as one graticule field.
17. Obtain reference selected area electron diffraction (SAED) or microdiffraction patterns from standard asbestos materials prepared for TEM analysis.
    NOTE: This is a visual reference technique. No quantitative SAED analysis is required [10]. Microdiffraction may produce clearer patterns on very small fibers or fibers partially obscurred by other material.
    a. Set the specimen holder at zero tilt.

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b. Center a fiber, focus, and center the smallest field-limiting aperture on the fiber. Use a 20-cm camera length and 10X binocular head. Obtain a diffraction pattern. Photograph each distinctive pattern and keep the photo for comparison to unknowns.

NOTE: Not all fibers will present diffraction patterns. The objective lens current may need adjustment to give optimum pattern visibility. There are many more amphiboles which give diffraction patterns similar to the analytes named on p.7402-1. Some, but not all, of these can be eliminated by chemical separations. Also, some non-amphiboles (e.g., pyroxenes, some talc fibers) may interfere.

18. Acquire energy-dispersive X-ray (EDX) spectra on approximately 5 fibers having diameters between 0.25 and 0.5 µm of each asbestos variety obtained from standard reference materials [10].

NOTE: The sample may require tilting to obtain adequate signal. Use same tilt angle for all spectra.

a. Prepare TEM grids of all asbestos varieties.
b. Use acquisition times (at least 100 sec) sufficient to show a silicon peak at least 75% of the monitor screen height at a vertical scale of ≥500 counts per channel.
c. Estimate the elemental peak heights visually as follows:
   (1) Normalize all peaks to silicon (assigned an arbitrary value of 10).
   (2) Visually interpret all other peaks present and assign values relative to the silicon peak.
   (3) Determine an elemental profile for the fiber using the elements Na, Mg, Si, Ca, and Fe. Example: 0-4-10-3-<1 [10].

   NOTE: In fibers other than asbestos, determination of Al, K, Ti, S, P, and F may also be required for fiber characterization.

   (4) Determine a typical range of profiles for each asbestos variety and record the profiles for comparison to unknowns.

MEASUREMENT:

19. Perform a diffraction pattern inspection on all sample fibers counted under the TEM, using the procedures given in step 17. Assign the diffraction pattern to one of the following structures:
   a. chrysotile;
   b. amphibole;
   c. ambiguous;
   d. none.

NOTE: There are some crystalline substances which exhibit diffraction patterns similar to those of asbestos fibers. Many of these, (brucite, halloysite, etc.) can be eliminated from consideration by chemistry. There are, however, several minerals (e.g., pyroxenes, massive amphiboles, and talc fibers) which are chemically similar to asbestos and can be considered interferences. The presence of these substances may warrant the use of more powerful diffraction pattern analysis before positive identification can be made. If interferences are suspected, morphology can play an important role in making positive identification.

20. Obtain EDX spectra in either the TEM or STEM modes from fibers on field samples using the procedure of step 18. Using the diffraction pattern and EDX spectrum, classify the fiber:
   a. For a chrysotile structure, obtain EDX spectra on the first five fibers; one out of ten thereafter. Label the range profiles from 0-5-10-0-0 to 0-10-10-0-0 as "chrysotile."
   b. For an amphibole structure, obtain EDX spectra on the first 10 fibers; one out of ten thereafter. Label profiles ca. 0-2-10-0-7 as "possible amosite"; profiles ca. 1-1-10-0-6 as "possible crocidolite"; profiles ca. 0-4-10-3-<1 as "possible tremolite"; and profiles ca. 0-3-10-0-1 as "possible anthophyllite."

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NOTE: The range of profiles for the amphiboles will vary up to ±1 unit for each of the elements present according to the relative detector efficiency of the spectrometer.

c. For an ambiguous structure, obtain EDX spectra on all fibers. Label profiles similar to the chrysotile profile as "possible chrysotile." Label profiles similar to the various amphiboles as "possible amphiboles." Label all others as "unknown" or "non-asbestos."

NOTE: Fibers smaller than 0.2 µm in diameter may not produce sufficient peak heights to allow an elemental profile to be determined. Identify these fibers as "unknown".

21. Counting and Sizing:

a. Insert the sample into the specimen grid holder and scan the grid at zero tilt at low magnification (ca. 300 to 500X). Ensure that the carbon film is intact and unbroken over ca. 75% of the grid openings.

b. In order to determine how the grid should be sampled, estimate the number of fibers per grid opening during a low-magnification scan (ca. 1000X). This will allow the analyst to cover most of the area of the grid during the fiber count and analysis. Use the following rules when picking grid openings to count [10]:

(1) Light (<5 fibers per grid opening): count every grid opening in which the carbon film is intact.

(2) Moderate (5 to 25 fibers per grid opening): count every fifth grid opening. If the carbon film is damaged, proceed to the next available grid opening in which the film is intact.

(3) Heavy (>25 fibers per opening): count every tenth grid opening. If the carbon film is damaged, proceed to the next available opening in which the carbon film is intact.

c. Increase magnification to 10,000X. Begin counting at one end of the grid and systematically traverse the grid by rows, reversing direction at row ends. Count at least 2 field blanks per sample set to document possible contamination of the samples. Use the mean fiber count for the field blanks, B, in step 22. Count fibers and asbestos structures using the following rules:

NOTE: Microscopes which traverse nonlinearly or erratically, causing incomplete coverage of the grid opening are not suitable for asbestos analysis [11]. Before using a specific microscope for counting, it should be examined for accuracy and reproducibility of traverses.

(1) Count all particles less than 3 µm diameter which meet the definition of a fiber (aspect ratio ≥3:1, with parallel sides).

NOTE: Particles which are of questionable morphology should be analyzed by SAED and EDX to aid in identification.

(2) Size each fiber as it is counted and record the diameter and length (mm):

(a) Move the fiber to the center of the screen. Read the length of the fiber directly from the scale on the screen.

NOTE: For fibers which extend beyond the field of view, the fiber must be moved and superimposed upon the scale until its entire length has been measured.

(b) When a fiber has been sized, return to the starting point and continue the traverse to the next fiber.

(3) Record other asbestos structures according to the following morphological definitions. Label combinations of these structures according to the dominant quality.

(a) Bundle - compact arrangement of parallel fibers in which separate fibers or fibrils may only be visible at the ends or edges of the bundle.

NOTE: Asbestos bundles having aspect ratios of 3:1 or greater and less than 3 µm in diameter are counted as fibers.

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(b) Cluster - network of randomly-oriented interlocking fibers arranged so that no fiber is isolated from the group. Dimensions of clusters can only be roughly estimated and clusters are defined arbitrarily to consist of more than four individual fibers [10].

(c) Matrix - one or more fibers attached to or embedded in a non-asbestos particle.

(4) Count fibers which are partially obscured by the grid.

NOTE: If a fiber is partially obscured by the grid bar at the edge of the field of view, count it as a fiber greater than 5 µm only if more than 2.5 µm of fiber is visible. Otherwise, log the fiber as a "short" fiber, measuring only that portion which is visible.

(5) When counting is complete, calculate the asbestos fiber fraction shorter than 5 µm and thinner than ca. 0.25 µm (the number of asbestos fibers which would be undetected by phase contrast microscopy).

d. Size all fibers using the scale on the fluorescent screen.

NOTE: Data can be recorded directly off the screen in mm and later converted to µm by computer. Count and record identified asbestos fibers and structures >1 µm long of all diameters [11]. However, when comparing TEM data to the PCM counts, all fibers, regardless of identification, greater than 5 µm long and between 0.25 and 3.0 µm diameter which have aspect ratios of 3:1 or greater should be included. This size adjustment is necessary to test comparability of counts between the two methods. If the size-adjusted counts show reasonable equivalency, then further analysis using the small-fiber data will show what fraction of airborne asbestos fibers is being missed by the PCM method.

CALCULATIONS:

22. Calculate and report fiber density on the filter, E, by dividing the total fiber count F, minus the mean field blank count, B, by the number of fields counted, n, (for each sample), and the field area, A_f.

$$E = \frac{\left(\frac{F}{n_f} - \frac{B}{n_b}\right)}{A_f}, \text{ fibers/mm}^2$$

NOTE: The field area, A_f, is considered to be one grid opening, and the size may vary depending upon the type of grids used. This value is known from step 16.

23. Calculate and report the average concentration, C, (fibers/mL) of fibers in the air sample, V (L), using the effective collection area of the filter, A_c (385 mm² for a 25-mm filter):

$$C = \frac{(E)(A_c)}{V \cdot 10^3}$$

24. As an integral part of the report, give the model and manufacturer of the TEM as well as the model and manufacturer of the EDS system.

EVALUATION OF METHOD:

The TEM method has been shown to have a precision of 0.275 (s_r) in an evaluation of mixed amosite and wollastonite fibers. The estimate of the asbestos fraction, however, had a precision of 0.11 (s_r). When this fraction was applied to the PCM count, the overall precision of the combined analysis was 0.20 [3].

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Appendix C

AIR SAMPLING SOP's FOR ASBESTOS

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ASBESTOS SAMPLING

.0 SCOPE AND APPLICATION

The objective of this document is to provide a standard operating procedure (SOP) to be utilized by USEPA Environmental Response Team (ERT) and Response, Engineering, and Analytical Contract (REAC) for sampling asbestos fibers in indoor and outdoor/ambient air at hazardous waste sites.

Regulations pertaining to asbestos have been promulgated by EPA and OSHA. EPA's National Emission Standards for Hazardous Air Pollutants (NESHAP) regulates asbestos-containing waste materials. NESHAP establishes management practices and standards for the handling of asbestos and emissions from waste disposal operations (40 CFR Part 61, Subparts A and M).

EPA's 40 CFR 763 (July 1, 1987) [1] and its addendum 40 CFR 763 October 30, 1987 [2] provide comprehensive rules for the asbestos abatement industry.

State and local regulations on these issues vary and may be more stringent than federal requirements.

The OSHA regulations in 29 CFR 1910.1001 and 29 CFR 1926.58 specify work practices and safety equipment such as respiratory protection and protective clothing when handling asbestos.

The OSHA standard for an 8-hour, time-weighted average (TWA) is 0.2 fibers/cubic centimeters of air. This standard pertains to fibers with a length-to-width ratio of 3 to 1 with a fiber length >5 um [3,4].

Fibers less than 0.25 um in length will not be detected by Phase contrac Microscopy. Transmission Electron Microscopy can detect very thin fiber typically down to 0.0025 um in diameter.

An action level of 0.1 fiber/cc (one-half the OSHA standard) is the leve EPA has established in which employers must initiate such activities as air monitoring, employee training, and medical surveillance [3,4].

References to specific analytical methodologies are made throughout this document and can be found in the Appendices.

2.0 METHOD SUMMARY

Asbestos has been used in many commercial products including building materials such as flooring tiles and sheet goods; paints and coatings; insulation, and roofing asphalts. These products and others may be four at hazardous waste sites either hanging on overhead pipes, contained in

ASBESTOS SAMPLING

drums, abandoned in piles, or as part of a structure. Asbestos tailing piles from mining operations can also be a source of ambient asbestos fibers.

Asbestos air sampling is conducted by drawing air through a filter at a known flow rate with a flow-controlled pump. The sample is then analyzed using Phase Contrast Microscopy (PCM) and/or Transmission Electron Microscopy (TEM).

PCM analysis is widely available and is less costly than TEM. TEM is considered the best method for identifying airborne asbestos. TEM can detect very thin fibers typically down to 0.0025 um in diameter.

When TEM (EPA) is compared with data from PCM (NIOSH), the TEM's aspect ratio of 5 to 1 should be modified to 3 to 1.

2.1 Sample Pumps

In order to determine if a sampling pump is measuring the flow rate or volume of air correctly, it is necessary to calibrate the instrument. Sampling pumps should be calibrated immediately before and after each use. Preliminary calibration should be conducted using a primary calibrator such as a soap bubble type calibrator, e.g., a Buck Calibrator, Gilibrator, or equivalent primary calibrator with a representative filter cassette installed between the pump and the calibrator. The representative sampling cassette can be reused for calibrating other pumps that will be used for asbestos sampling. The same cassette lot used for sampling should also be used for the calibration. A sticker should be affixed to the outside of the extension cowl marked "Calibration Cassette." A rotometer can be used provided it has been recently precalibrated with a primary calibrator. Three separate constant flow calibration readings should be obtained both before and after collecting the sample. Should the flow rate change by more than 5% during the sampling period, the average of the pre- and post-calibration rates will be used to calculate the total sample volume. Sampling pumps can be calibrated prior to coming on-site so that time is saved when performing on-site calibration.

2.1.A Personal Sampling Pumps

Personal sampling pumps are utilized when the flow rates are between .001 L/min to 5 L/min. Many lightweight portable pumps are capable of providing high or low volume air flow. See manufacturer's manual for pump operation.

2.1.B High Flow Pumps

High flow pumps are utilized when flow rates between 4 L/min to 16 L/min are required. High flow pumps are used for short sampling periods so as to obtain the desired sample volume. ERT uses the Gilian Aircon 520's. An equivalent high flow pump can also be used.

The high flow pumps usually run on AC power and can be plugged into a nearby outlet. If an outlet is not available then a generator should be obtained. The generator should be positioned downwind from the sampling pump. Additional voltage may be required if more than one pump is plugged into the same generator. Several electrical extension cords may be required if sampling locations are remote.

2.2 Outdoor/Ambient Sampling

ERT uses PCM analysis for outdoor/ambient air samples. When analysis shows total fiber count above the OSHA action level 0.1 f/cc then TEM can be used to identify asbestos from non-asbestos fibers. Some labs are able to perform PCM and TEM analysis on the same filter.

High volume pumps are, for the most part, used for outdoor sampling in low dusty areas. The samplers should be placed above ground level, about 4 to 5 feet high, away from obstructions that may influence air flow see Table 2.1.

Outdoor sampling usually requires flow rates between 10 to 15 L/min with a sample volume of 1000 to 5000 liters (PCM).

2.1.D.1 Environmental Data

Record wind speed, wind direction, temperature, and pressure in a field logbook. Wind direction is particularly important when monitoring for asbestos downwind from a fixed source.

- CALIBRATE with filter
4-5
- TAKE DUST Sample till Filter DARKENS (in DUSTY AREA)

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201.
0:
10/:

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TABLE 2.1. SAMPLING STATIONS

Sampling Station Location		Rationale
Upwind/Background	Collect a minimum of 2 simultaneous upwind/background samples 30o apart from the prevailing windlines.	Establishes background fiber levels.
Downwind	Deploy a minimum of 3 sampling stations in a 180o arc downwind from the source.	Indicates if asbestos is leaving the site.
Site Representative and/or Worse Case	Obtain one site representative sample which shows average condition on-site or obtain worse case sample (optional).	Verify and continually confirm and document selection of proper levels of worker protection.

*NOTE: More than one background station may be required if the asbestos orig from different sources.

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It is recommended that a meteorological station be established. If possible, sample after 2 to 3 days of dry weather and when the wind conditions are at 10 mph or greater.

2.3 Indoor Sampling

ERT uses PCM analysis for indoor air samples. When analysis shows total fiber count above the OSHA action level 0.1 f/cc then TEM can be used to identify asbestos from nonasbestos fibers. See Section 3.0.

Sampling pumps should be placed 4 to 5 feet above ground level away from obstructions that may influence air flow. The pump can be placed on a table or counter. See Table 2.2.

Indoor sampling generally utilizes high flow rates and increased sample volumes in order to obtain lower detection limits, i.e., 0.01 f/cc or lower (PCM) and 0.005 structures/cc or lower (TEM).

2.3.A Aggressive Sampling

Sampling equipment at fixed locations may fail to detect the presence of fiber. Due to limited air movement, many fibers may settle out of the air onto the floor and other surfaces and may not be captured on the filter. In the past an 8-hour sampling period was recommended to cover various air circulation conditions. A quicker and more effective way to capture asbestos fibers is to circulate the air artificially so that the fibers remain airborne during sampling. The results from this sampling option typify worse case condition. This is referred to as aggressive air sampling for asbestos. For more detailed information see [7.4].

Note: The individual performing this task should follow regulations regarding respiratory protection 29 CFR 1910.1001

2.3.B Aggressive Sampling Procedures

1. Before starting the sampling pumps, direct forced air (such as a 1-horsepower leaf blower or large fan) against walls, ceilings, floors, ledges, and other surfaces in the room to initially dislodge fibers from surfaces. This should take at least 5 minutes per 1000 sq. ft. of floor.

2. Place a 20-inch fan in the center of the room. (Use one fan per 10,000 cubic feet of room space.) Place the fan on slow speed and point it toward the ceiling.
3. Start the sampling pumps and sample for the required time.
4. Turn off the pump and then the fan(s) when sampling is complete.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

3.1 Filter selection and collection device.

The filter selection and collection device for sample collection will depend upon which analytical methodology is utilized.

a) NIOSH Method 7400: Phase Contrast Microscopy involves using a 0.8 to 1.2 um cellulose ester membrane, 25 mm diameter; 50 mm conductive cowl on cassette (see Figure 3.1).

b) EPA Transmission Electron Microscopy involves using a 25 mm filter cassette with either a polycarbonate filter having a pore size ≤0.4 um or mixed cellulose ester filter (MCE) having a pore size ≤0.45 um. This cassette includes an extension cowl, a 5.0 um MCE backup filter, to serve as a diffuser, and a support pad (see Figure 3.2).

3.2 Sample Handling Procedures

1. Place a sample label on the cassette indicating a unique sampling number. Do not put sampling cassettes in shirt or coat pockets as the filter can pick up fibers. ERT uses the original cassette box to hold the samples.
2. Wrap the cassette individually in a plastic sample bag. Each bag should be marked indicating sample identification number, total volume, and date.
3. The wrapped sampling cassettes should be placed upright in a rigid container so that the cassette cap is on top and cassette base is on bottom. Use enough packing material to prevent jostling or damage. If possible, hand carry to lab.
4. Provide appropriate documentation with samples, i.e., chain of custody and requested methodology.

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TABLE 2.2. SAMPLING STATIONS

Sampling Station Location		Rationale
Indoor Sampling	If a work site is a single room, disperse 5 samplers throughout the room.	Establishes repre sentative samples from a homogeneou area.
	If the worksite contains up to 5 rooms, place at least one sampler in each room.	
	If the worksite contains more than 5 rooms, select a representative sample of the rooms.	
Upwind/Background	If outside sources are suspected, deploy a minimum of two simultaneous upwind/background samples 30o apart from the prevailing windlines.	Establishes wheth indoor asbestos concentrations ar coming from an o. side source.
Worse Case	Obtain one worse case sample, i.e., aggressive sampling (optional).	Verify and continually confi and document selection of prop levels of worker protection.

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5. Follow all QA/QC requirements from the lab as well as from the PCM/TEM analytical methodology, i.e., field blank, lot blank requirements.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Flow rates should not exceed 16 L/min due to the possibility of asbestos fiber disintegration upon contact with the filter.

4.1 NIOSH Method 7400, PCM (can be found in Appendix A).

Limitations:

1. PCM cannot distinguish asbestos from nonasbestos fibers. All particles meeting the counting criteria are counted as total asbestos fibers.
2. Fiber less than 0.25 um in length will not be detected by this method.
3. High levels of non-fibrous dust particles may obscure fibers in the field of view and increase the detection limit.

4.2 EPA's TEM method (can be found in Appendix B).

Limitations:

1. High concentrations of background dust interfere with fiber identification.

5.0 EQUIPMENT

5.1 Equipment List - Personal Sampling Pump

1. Personal sampling pump (etc. Gilian Personal Sampler).
2. Inert tubing with glass cyclone and hose barb.
3. Sampling cassettes with conductive cowl.
4. Appropriate membrane filters.
5. Rotometers.
6. Whirlbags for cassettes.
7. Tools - small screw drivers.
8. Sample labels.
9. Air data sheets.
10. Container - to keep samples upright.

5.2 Equipment List - High Flow Pump

1. High flow pump (etc. Gilian Aircon).
2. Generator or electrical outlet.
3. Extension cords.

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4. Rotometers.
5. Inert tubing - unless provided with pump.
6. Sampling cassettes with conductive cowl.
7. Appropriate membrane filters.
8. Whirlbags for cassettes.
9. Sample labels.
10. Air data sheets.
11. Container - to keep samples upright.

6.0 REAGENTS

There are no reagents used in the sampling phase or the analytical phase of Asbestos Sampling.

7.0 PROCEDURES

7.1 Field Procedures - Personal Sampling Pump

1. Charge the unit for the maximum required time as indicated in t manufacturer's manual.
2. Once on-site in the clean zone follow the calibration procedure in Section 9.1-9.3.
3. Mobilize to the sampling location.
4. To set up the sampling train, attach one end of the Polyvinyl Chloride (PVC) tubing (approx. 2 ft) to the cassette base; atta the other end of the tubing to the inlet plug on the pump (see Figure 7.1). The attachment between the cassette base and the tubing can best be achieved by using a hose barb with cyclone.
5. Place the sampling pump 6 ft. above ground level (in the breathing zone) and in an area that will not be affected by unusual air flow. The sampling pump and cassette can be placed on a sturdy structure, attached to a dowel rod or hooked to an object, i.e., fence.
6. Remove the cassette cap from the extension cowl (open faced) an orient the cassette perpendicular to the wind.
7. Adjust the time on the pump. If the pump is programmable turn past the zero mark before setting the actual time.
8. Turn the pump on.
9. Record the following in a field logbook:

   a. Date, time, location (area or room), sample identification number, and pump number.
   b. Flow rate and desired total sampling time.

10. Record weather data (i.e. ambient temperature, wind direction, windspeed, precipitation).

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11. Check the pump at midpoint of the sampling period if longer than 4 hours.
12. If a filter darkens in appearance of if loose dust is seen in the filter, a second sample should be started.
13. At the end of the sampling period, check the fault button to obtain pump sampling time. (This indicates whether or not the pump ran the full programmable timespan). Be sure to orient the cassette in an upright position to prevent fibers from falling from the filter when the vacuum is released.
14. Record the pump run time (finish time minus start time).
15. Perform post calibration procedures as shown in Section 9.0
16. Record the post flow rate in a field logbook.
17. Remove the PVC tubing from the sampling cassette. Still holding the cassette upright, replace the inlet plug on the cassette cap.
18. Place the outlet plug on the cassette base.
19. Refer to Section 3.2, Steps 1-5 for sample handling procedures.

7.2 Field Procedures - High Flow Pump

The following instructions are for a Gilian Aircon 520 Constant High Flow Air Sampler and is used for illustrative purposes; an equivalent high flow pump can be used instead.

1. Once on-site the calibration is performed in the clean zone. The calibration procedures for personal sampling pumps listed in Section 9.1 are also applicable to high volumes sampling pumps.
2. After calibrating the high volume sampler, mobilize to the sampling location.
3. To set up the sampling train, attach the air intake hose to the cassette base. Remove the cassette cap. The cassette should b positioned perpendicular to the wind (See Figure 7.2).
4. Turn the generator on. The generator should be placed 10 ft. downwind from the sampling pump.
5. Record the pumps cumulative time (if applicable).
6. Record the following in a field logbook:
   a. Date, time, location, sample identification number, and pum number.
   b. Flow rate and cumulative time.

7. Record weather: wind speed, ambient temperature, wind direction, and precipitation.
8. Turn the pump on.

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9. Check the pump at sampling midpoint if longer than 4 hours.
10. At the end of the sampling period, orient the cassette up, the pump off.
11. Record the cumulative time (if applicable).
12. Check the flow rate as shown in section 9.0. The sampling cap replaced before calibrating.
13. Record the post flow rate.
14. Remove the tubing from the sampling cassette. Still holding the cassette upright, replace the inlet plug on the cassette cap and the outlet plug on the cassette base.
15. Refer to Section 3.2 steps 1-5 for sample handling procedures.

7.3 Calibration Procedures

EPA/ERT uses an electronic calibrator for calibrating rotometers and pumps. Refer to Section 9.1-9.3 for calibration procedures.

8.0 CALCULATIONS

8.1 Sample volume and flow rate

The sampling volumes are determined on the basis of how many fibers need to be collected for reliable measurements. Therefore, one must estimate how many airborne fibers may be in the sampling location.

Since the concentration of airborne aerosol contaminants will have some affect on the sample, the following is a suggested criteria to assist in selecting a flow rate based on real-time aerosol monitor readings in mg/m3.

	Concentration	Flow Rate
1. Low real-time monitor readings:	<6.0 mg/m3	11-15 L/min
2. Medium real-time monitor readings:	≥6.0 mg/m3	7.5 L/min
3. High real-time monitor readings:	≥10 mg/m3	2.5 L/min

a) PCM utilizes flow rates between 0.5 L/min and 16 L/min. Sampling time is adjusted to obtain optimum fiber loading on the filter. A sampling rate of 1 to 4 L/min for 8 hrs is appropriate in non-dusty atmospheres containing 0.1 fiber/cc. Dusty atmospheres i.e., areas with high levels of asbestos, require smaller sample volumes (<400 L) to obtain countable samples. In such cases, take short, consecutive samples and average the results over the total collection time. For documenting episodic exposures, use high flow rates (7 to 16 L/min) over shorter sampling times. In relatively clean atmospheres where targeted fiber concentrations are much less than 0.1 fiber/cc, use larger sample volumes (3,00 to 10,000 L) to achieve quantifiable loadings. Take care, however, not to overload the filter with background dust. If ≥ 50% of the fiber surface is covered with particles, the filter may be too overloaded to count and will bias the measur concentration. Do not exceed 0.5 mg total dust loading o filter.

b) EPA's TEM requires a minimum volume of 560 liters (L) and a maximum volume of 3,800 L in order to obtain an analytical sensitivity of 0.005 structures/cc. The optimal volume for TEM is 1200 L to 1800 L. These volumes are determined using a 200 mesh EM grid opening with a 25-mm filter cassette. Changes in volume would be necessary if a 37-mm filter cassette is used since the effective area of a 25 mm (385 sq mm) and 37 mm (855 s m) differ. (See Table 1 in the TEM Methodology, Appendix B.)

9.0 QUALITY ASSURANCE/QUALITY CONTROL

Follow all QA/QC requirements listed in the analytical method.

Generally field blanks are required for each set of samples or 10% of the total samples, whichever is greater.

The laboratory analyzing the samples should determine the lot blank requirements. There should be no less than 1 lot blank per cassette lot.

9.1 Calibrating a personal sampling pump with an electronic calibrator.

1. See manufacturer's manual for operational instructions.
2. Set up the calibration train as shown in Figure 9.1 using a sampling pump, electronic calibrator, and a representative filt cassette. The same lot sampling cassette used for sampling should also be used for calibrating.
3. To set up the calibration train, attach one end of the PVC tubi (approx. 2 foot) to the cassette base; attach the other end of the tubing to the inlet plug on the pump. Another piece of tubing is attached from the cassette cap to the electronic calibrator.
4. Turn the electronic calibrator and sampling pump on. Create a bubble at the bottom of the flow chamber by pressing the bubble initiate button. The bubble should rise to the top of the flow chamber. After the bubble runs its course, the flow rate is shown on the LED display.
5. Turn the flow adjust screw or knob on the pump until the desire flow rate is attained.
6. Perform the calibration 3 times until the desired flow rate of 5% is attained.

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9.2 Calibrating a rotometer with an electronic calibrator.

1. See manufacturer's manual for operational instructions.
2. Set up the calibration train as shown in Figure 9.2 using a sampling pump, rotometer, and electronic calibrator.
3. Assemble the base of the flow meter with the screw provided and tighten in place. The flow meter should be mounted within 6o vertical.
4. Turn the electronic calibrator and sampling pump on.
5. Create a bubble at the bottom of the flow chamber by pressing the bubble initiate button. The bubble should rise to the top of the flow chamber. After the bubble runs its course, the flow rate i shown on the LED display.
6. Turn the flow adjust screw or knob on the pump until the desired flow rate is attained.
7. Record the electronic calibrator flow rate reading and the corresponding rotometer reading. Indicate these values on the rotometer (sticker). The rotometer should be able to work withi the desired flow range.
8. Perform the calibration 3 times until the desired flow rate of ± 5% is attained.

Once on site, a secondary calibrator, i.e., rotometer is used to calibrate sampling pumps.

9.3 Calibrating a sampling pump with a rotometer.

1. See manufacturer's manual for Rotometer's Operational Instructions.
2. Set up the calibration train as shown in Figure 9.3 using a rotometer, sampling pump, and a representative sampling cassette
3. To set up the calibration train, attach one end of the PVC tubir (approx. 2 ft) to the cassette base; attach the other end of the tubing to the inlet plug on the pump. Another piece of tubing : attached from the cassette cap to the rotometer.
4. Assemble the base of the flow meter with the screw provided and tighten in place. The flow meter should be mounted within 6o vertical.
5. Turn the sampling pump on.
6. Turn the flow adjust screw (or knob) on the personal sampling pump until the float ball on the rotometer is lined up with the precalibrated flow rate value. A sticker on the rotometer shou indicate this value.
7. A verification of calibration is generally preformed on-site in the clean zone immediately prior to the sampling.

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10.0 DATA VALIDATION

PCM analysis does not distinguish between asbestos and non-asbestos fibers, all fibers meeting the criteria are counted. TEM analysis can distinguish asbestos from non-asbestos fibers. This method of analysis should be used when the total fiber count is above the action level (or level of concern) so as to determine whether the airborne fiber is of asbestos origin.

Note: The flow rate and time should be adjusted to obtain optium fiber loading on the filter.

11.0 HEALTH AND SAFETY

When entering an unknown situation involving asbestos, a powered air purifying respirator (PAPR) (full face-piece) is necessary in conjuncti with HEPA filter cartridges. See applicable regulations for action level, PEL, TLV, etc. If previous sampling indicates asbestos concentrations are below the action level, then EPA Level D personal protection is adequate.

12.0 REFERENCES

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3. Occupational Safety and Health Administration. Code of Federal Regulations 29 CFR 1910.1001. Washington, D.C. 1987.

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6. Turpin, Rodney. Generic Asbestos Air Monitoring Guide for Hazardou Sites. U.S. Environmental Protection Agency Environmental Response Team. January 1988.

7. U.S. Environmental Protection Agency. Field Standard Operating Procedures (FSOP) #8 Air Surveillance, Office of Emergency and Remedial Response, Hazardous Response Support Division, Environment Response Team. January 1988.

8. Keyes, D.L., Price, B.P., and Chesson, J. Guidance for Controlling Asbestos-Containing Materials in Buildings; U.S. Environmental Protection Agency, EPA 560/5-85-024. June 1985.

13.0 APPENDICES

A. NIOSH Method 7400, PCM
B. EPA's TEM Method

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